IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor: §

CHOSACK et al. §

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Group Art Unit: 3713

For: ENDOSCOPIC TUTORIAL SYSTEM §

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Examiner: C. SAADAT §

Commissioner of Patents and Trademarks
P.O. Box 1450
Alexandria, VA 22313

AFFIDAVIT UNDER 37 CFR 1.132

I, Ran Bronstein, am the CEO of Simbionix Ltd., Israel. I have a B.Sc. degree in Computer Science and Mathematics, which I received from The Hebrew University of Jerusalem (Jerusalem, Israel). My professional specialization is in the field of computer graphics and image processing. I have attached a copy of my curriculum vitae.

I am an inventor of the present invention. I have read the present application and the new and amended claims, as well as the Office Action from the Examiner and the accompanying references. In support of the accompanying Response to this Office Action, I have provided additional details concerning the operation of the present invention.

Briefly, the present invention relates to a method for modeling or simulating an organ for learning purposes, and in particular, to a system in which a two dimensional spline, to which other two-dimensional constructs are added, such that the combination forms an

amended claims, and as described in the specification, the present invention seeks to model an organ, not by creating a three dimensional model of the organ, but instead by creation of a two dimensional approximation of the modeled three dimensional space. In addition the spline is used for calculating the movement model and the resultant shape of the endoscope within the three-dimensional organ space for example while creating a loop. . In order to simulate the shape of the loop, the length of the (virtual) cable which has been fed into the modeled colon is determined, as well as the length of the modeled colon from the entry point to the position of the endoscope. The size of the loop is calculated from the differential of the two lengths, and the loop is modeled according to the spline modeling the organ. Additionally, the formed loop is preferably simulated through inclusion of the history of endoscope movement within the colon, which helps determine the visual feedback.

Since the spatial movement of the simulated endoscope is limited and because the simulated endoscope must pass through every segment of the organ in sequence at a known limited speed, the movement in the organ is portrayed according to a division of the organ into a plurality of portions. The division enables only one segment to be simulated at once, and reduces the visual processing into a manageable task, as each segment has fewer polygons modeling it than the number used to model the whole organ. As the endoscope moves along the segments, the model of the spline is recalculated, as the movement may cause deformations affecting the spline itself, and if necessary is preferably altered locally.

The present invention represents a significant, non-obvious, inventive advance over the background art such as "Interactively Deformable Models for Surgery Simulation" written by Cover et al, for example, as Cover teaches an organ modeling method, performed by using the concept of an active surface, which is an energy minimizing spline extended into an energy minimizing surface in a three dimensional space. The basic hypothesis of Cover is that the active surface will seek energy minima, and therefore deformations to the surface are unstable. In order to create a model of an organ, a spline is extended into a three dimensional surface.

Splines are piecewise polynomials where the degree of the polynomial determines the continuity and smoothness of the function approximation. Additional smoothing constraints can be introduced by penalty terms which reduce the size of various differentials. One way to view spline fitting is in the form of an energy functional such as Equation 6.

$$E_{spline}(\hat{f}) = \int_R \left(E_{fit}(\hat{f}) + E_{smooth}(\hat{f})\right) ds \qquad (6)$$

Here, there is an energy associated with the goodness of fit, some measure of how close the approximating function is to the input function. This is typically the least squares distance between the functions. There is an energy associated with the smoothness of the function. Two very commonly used smoothness controls produce the membrane and thin plate splines by restricting the first and second differentials of the function respectively. To fit the spline to the function, the total energy must be minimized. A necessary condition for this is an Euler-Lagrange differential equation such as Equation 7. Here ω_t controls the tension in the spline (the resistance to stretching) and ω_s the stiffness (the resistance to bending). Often the error function will be based on individual data points and the left hand side of Equation 7 would include delta functions.

$$-\frac{\partial}{\partial s}\left(\omega_t(s)\frac{\partial \hat{f}(s)}{\partial s}\right) + \frac{\partial}{\partial s^2}\left(\omega_s(s)\frac{\partial^2 \hat{f}(s)}{\partial s^2}\right) = f_{in}(s) - \hat{f}(s) \qquad (7)$$

Splines may be used for a number of purposes.

I hereby certify that the above facts and statements are true and complete, to the best of my knowledge.

Ran Bronstein

Date: 3/12/2003

RESUME

General:

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Education:

1991 - 1992 Hebrew University - Jerusalem
Masters Degree in Computer Science
Specialization: Image Processing
Councilors: Prof. Samuel Peleg
Dr. Michael Werman
Completed with Distinction and Final grade of 93.

1988 - 1990 Hebrew University - Jerusalem
Bachelors Degree in Mathematics and Computer Science
Dean's List first year.
Completed with Distinction and Final grade of 90.

1976 - 1982 Hebrew University High School, Jerusalem.

Experience:

2002 - **Simbionix** Ltd. – CEO.

1998 –2001 **Simbionix** Ltd. - CTO (Chief Technology Operation) and a founder. Developing of Medical Simulators and Clinical products for the MIS market, composed of real-time 3D graphics, image processing, tracking and force-feedback technologies for human interaction.

1999-2001 Lecturer in the "**Camera Obscura**" college , subject "Computer graphics and interactive multimedia".

1998 Lecturer in the **Open University** in Jerusalem, subject "Introduction to Computer Science".

1995 - 1998 **Kidum Multimedia/S.E.A Multimedia** - R&D manager. Responsible for the development of two games: ***Roboquest***, which was published by Philips Multimedia and ***Virus - The Game***, which was published by Telstar in Europe and Sirtech

in the US (sold 80.000 copies). In addition responsible for the development of Internet gaming engine (Plugin & ActiveX) based on the principle : WYSWYS - what you see is what you stream.

Main subjects of development : Real-Time 3D, Geometry compression, Geometry streaming through the Internet, VRML 2.0.

Working Environments: Win95, DirectX, Visual C++, ActiveX, Netscape SDK, Win32, COM/DCOM.

Size of R&D team: 30 people.

Kidum was acquired by S.E.A multimedia in 1997.

1992 -1995 **Tecnomatix** Ltd. (NASDAQ Symbol: TCNO) , Herzlia.
Working and later Management of Computer Graphics for Robot's simulation group.

Project Manager of Windows-NT porting of the **Tecnomatix** core technologies: Robotics,3D graphics, Kinematics, Communication and User Interface components.
Experience with graphic libraries (GL & OpenGL) on SGI, X-Windows, MFC, Lex &Yacc.

Working Environments: Unix on workstation, Windows NT on P.C.

1992 Lecturer in the Open University in Jerusalem, subject - C, C++.

1989 - 1992 Hebrew University, Jerusalem - Humanities Faculty
Support of User Terminal Rooms.

Publications: Recovery of Surfaces form their Derivatives,
Ran Bronstein, Michael Werman & Samuel Peleg
IAPR, the Hage Holland, September 1992.

Languages: Hebrew and English.

Working Environment Experience: UNIX, WinNT, Win95.
GL, OpenGL, DirectX.
Visual C++, MFC.